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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] In the wavelength asynchronous transfer mode device equipped with the wavelength multiplexing transmitting means and the wavelength multiplexing receiving means of transmitting and receiving a wavelength multiplexing lightwave signal, through the working optical transmission line or the reserve optical transmission line said wavelength multiplexing transmitting means As opposed to m input signals (m is two or more integers) the method way of an output of an individual (m+n) (n is an integer below or more 1m) A selectable signal selection circuitry, m working light transmitters and n reserve light transmitters which output the lightwave signal of wavelength which is connected to each output terminal of said signal selection circuitry, and is mutually different according to the output signal, The wavelength asynchronous transfer mode device characterized by having a wavelength multiplexing means to output the lightwave signal outputted from said working light transmitter and said reserve light transmitter to wavelength many weights, said working optical transmission line, or said reserve optical transmission line.
[Claim 2] A signal selection circuitry is a wavelength asynchronous transfer mode device characterized by being the configuration which changes the input signal linked to the working light transmitter to i reserve light transmitters when sometimes usually connecting m input signals to m working light transmitters in a wavelength asynchronous transfer mode device according to claim 1 and changing i of said m working light transmitters (i is an integer below or more 1n) to a reserve light transmitter.
[Claim 3] It is the wavelength asynchronous transfer mode device which carries out wavelength multiplexing of the lightwave signal with which a wavelength multiplexing means is usually sometimes outputted from a working light transmitter in a wavelength asynchronous transfer mode device according to claim 1, and is characterized by being the configuration which carries out wavelength multiplexing of the lightwave signal outputted from a working light transmitter and a reserve light transmitter, and is outputted to an optical transmission line when it outputs to an optical transmission line, it replaces with some working light transmitters and a reserve light transmitter is used.
[Claim 4] A wavelength multiplexing means is a wavelength asynchronous transfer mode device characterized by having the signal selection circuitry which changes the input port of said wavelength multiplexing means by which the lightwave signal outputted from the reserve light transmitter is connected when it has the wavelength dependency it is decided in a wavelength

asynchronous transfer mode device according to claim 3 according to input port and input wavelength that an output port will be, it replaces with some working light transmitters and a reserve light transmitter is used.

[Claim 5] In the wavelength asynchronous transfer mode device equipped with the wavelength multiplexing transmitting means and the wavelength multiplexing receiving means of transmitting and receiving a wavelength multiplexing lightwave signal, through the working optical transmission line or the reserve optical transmission line said wavelength multiplexing receiving means A wavelength separation means to divide into the lightwave signal of each wavelength the wavelength multiplexing lightwave signal inputted from said working optical transmission line or said reserve optical transmission line, m working light receivers (m is two or more integers) and n reserve light receivers (n is the integer below or more 1m) which are connected to each output terminal of said wavelength separation means, and receive the lightwave signal of each wavelength corresponding to each output terminal, The wavelength asynchronous transfer mode device characterized by having a selectable signal selection circuitry for m method ways of an output to the input signal of the individual outputted from said m working light receivers and said n reserve light receivers (m+n).

[Claim 6] It is the wavelength asynchronous transfer mode device characterized by being the configuration which changes the output signal of the working light receiver to the output signal of a reserve light receiver in a wavelength asynchronous transfer mode device according to claim 5 when a signal selection circuitry sometimes usually outputs the output signal of m working light receivers and i of said m working light receivers (i is an integer below or more 1n) are changed to a reserve light receiver, and outputs.

[Claim 7] In a wavelength asynchronous transfer mode device according to claim 5 a wavelength separation means Usually, when separate spectrally the wavelength multiplexing lightwave signal from a working optical transmission line into each wavelength, it inputs into a working light receiver, it replaces with some working light transmitters and a reserve light transmitter is sometimes used Or the wavelength asynchronous transfer mode device characterized by being the configuration of inputting into the working light receiver and reserve light receiver which separate spectrally into each wavelength the wavelength multiplexing lightwave signal inputted from a working optical transmission line, and correspond, respectively when it replaces with some working light receivers and a reserve light receiver is used.

[Claim 8] A wavelength multiplexing receiving means according to claim 5 to receive the wavelength multiplexing lightwave signal inputted from an optical transmission line, Two or more wavelength asynchronous transfer mode devices equipped with a wavelength multiplexing transmitting means according to claim 1 to transmit the wavelength multiplexing lightwave signal outputted to an optical transmission line, In the wavelength multiplex transmission system which connected to concatenation one or more junction optical amplifiers arranged between each wavelength asynchronous transfer mode device The wavelength multiplex transmission system characterized by being the configuration which makes the same wavelength (reserve wavelength) of the lightwave signal transmitted to a reserve light receiver from a reserve light transmitter between each wavelength asynchronous transfer mode device.

[Claim 9] The wavelength multiplex transmission system which carries out the monitor of the lightwave signal of reserve wavelength between each wavelength asynchronous transfer mode device, and is characterized by being the configuration with which the gain control of a junction optical amplifier, an output light level control, or control of the both is presented in a wavelength multiplex transmission system according to claim 8.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] this invention -- present -- business -- it is related with the wavelength multiplex transmission system which connected a wavelength asynchronous transfer mode device and it equipped with the system and the reserve system to concatenation. failure of the equipment which transmits and receives a wavelength multiplexing lightwave signal especially, or failure of the optical transmission line which transmits a wavelength multiplexing lightwave signal -- receiving -- present -- business -- it is related with a configuration for the change in a reserve system from a system to perform failure restoration.
[0002]
[Description of the Prior Art] drawing 11 -- present -- business -- the example of a configuration of the conventional wavelength asynchronous transfer mode device equipped with the system and the reserve system is shown. drawing -- setting -- the wavelength multiplexing transmitting means 51-1, 51-2, an optical transmission line 52-1, 52-2, the wavelength multiplexing receiving means 53-1, and 53-2 -- respectively -- present -- business -- it is independently arranged as a system and a reserve system. The wavelength multiplexing transmitting means 51-1 and 51-2 are constituted by an optical transmission line 52-1 and the optical multiplexing machine 55 sent out to 52-2 by carrying out wavelength multiplexing of the lightwave signal of each wavelength to n optical transmitters 54 with which light source wavelength differs mutually. The wavelength multiplexing receiving means 53-1 and 53-2 are constituted by an optical transmission line 52-1, the optical separator 56 which separates spectrally into each wavelength the wavelength multiplexing lightwave signal inputted from 52-2, and n optical receivers 57 which receive the lightwave signal of each wavelength. here -- present -- business -- p shows the channel of w and a reserve system for the channel of a system.
[0003]
[Problem(s) to be Solved by the Invention] the conventional wavelength asynchronous transfer mode device -- equipment failure or optical transmission line failure -- receiving -- present -- business -- it has composition which carries out failure restoration by changing from a system to

a reserve system. The trouble at this time is explained with reference to drawing 12 . Here, a two-channel multiple configuration is shown.

[0004] drawing 12 (a) it is shown -- as -- present -- business -- the time of one channel of the wavelength multiplexing transmitting means 51-1 of a system breaking down -- drawing 12 (c) if only one of them is changed to the wavelength multiplexing transmitting means 51-2 of a reserve system so that it may be shown -- both optical transmission lines 52-1 and 52-2 -- present -- business -- it will become a system. Such a situation becomes the cause of derangement of a system on maintenance / employment and is not desirable. Also in the case of failure [in order to avoid it] of one channel, it is drawing 12 (d). All channels are collectively changed to a reserve system so that it may be shown, and it is made to apply only by the piece system. moreover, drawing 12 (b) it is shown -- as -- present -- business -- the case where the optical transmission line 52-1 of a system breaks down -- drawing 12 (d) All channels are collectively changed to a reserve system so that it may be shown.

[0005] thus, the conventional wavelength asynchronous transfer mode device -- wavelength multiplexing transmitting means, optical transmission lines, and all the wavelength multiplexing receiving means -- present -- business -- it has composition equipped with the reserve system other than a system. Therefore, especially, the optical transmitter and the optical receiver became twice as required as the number of channels, and caused a cost rise of a wavelength asynchronous transfer mode device.

[0006] This invention constitutes a reserve system from minimum device, and aims at offering the wavelength asynchronous transfer mode device and wavelength multiplex transmission system which can reduce the cost for a doubleness configuration.

[0007]

[Means for Solving the Problem] Drawing 1 shows the basic configuration and the example of a change of a wavelength asynchronous transfer mode device of this invention. In drawing, the wavelength multiplexing transmitting means 10 receives m input signals (m is two or more integers) S1-Sm. The method way of an output of an individual (n is an integer below or more 1m) The selectable signal selection circuitry 11, (m+n) It is constituted by the wavelength multiplexing means 14 which light source wavelength carries out wavelength multiplexing of the lightwave signal of each wavelength to m optical transmitters 12-1 - 12mutually different-m, and mutually different n optical transmitters 13-1 - 13-n, and sends out to an optical transmission line 52-1 or an optical transmission line 52-2. The wavelength multiplexing receiving means 20 is constituted by the selectable signal selection circuitry 24 in m method ways of an output to m optical receivers 22-1 - 22-m and n optical receivers 23-1 - 23-n which receives a wavelength separation means 21 to separate spectrally into each wavelength the wavelength multiplexing lightwave signal inputted from an optical transmission line 52-1 or an optical transmission line 52-2, and the lightwave signal of each wavelength, and the input signal of an individual (m+n). here -- present -- business -- p shows the channel of w and a reserve system for the channel of a system.

[0008] drawing 1 (a) the optical transmitter 12-1 - 12-m, an optical transmission line 52-1, the optical receiver 22-1 - 22-m -- present -- business -- it considers as a system and the normal state which employs the optical transmitter 13-1 - 13-n, an optical transmission line 52-2, the optical receiver 23-1 - 23-n as a reserve system is shown. That is, the signal selection circuitry 11 of the wavelength multiplexing transmitting means 10 connects m input signals S1-Sm to the optical transmitter 12-1 - 12-m, and the wavelength multiplexing means 14 carries out wavelength multiplexing of the lightwave signal outputted from the optical transmitter 12-1 - 12-m, and it

sends it out to an optical transmission line 52-1. The wavelength separation means 21 of the wavelength multiplexing receiving means 20 divides into each wavelength the wavelength multiplexing lightwave signal inputted from an optical transmission line 52-1, and connects it to the optical receiver 22-1 - 22-m, and the input signal is outputted through the signal selection circuitry 24.

[0009] drawing 1 (b) present -- business -- the optical transmitter 12-1 of a system breaks down, and the condition of changing and applying to the optical transmitter 13-1 of a reserve system is shown. That is, the signal selection circuitry 11 of the wavelength multiplexing transmitting means 10 changes the input signal S1 linked to the optical transmitter 12-1 to the optical transmitter 13-1, and the wavelength multiplexing means 14 carries out wavelength multiplexing of the optical transmitter 12-2 - 12-m, and the lightwave signal outputted from 13-1, and it sends it out to an optical transmission line 52-1. At this time, the wavelength of the lightwave signal transmitted from the optical transmitter 13-1 of a reserve system is set as the same wavelength as the broken optical transmitter 12-1, or other wavelength.

[0010] With the wavelength multiplexing receiving means 20, as the optical receiver 22-1 receives or it is shown in drawing according to the wavelength of the lightwave signal transmitted from the optical transmitter 13-1 of a reserve system, the optical receiver 23-1 of a reserve system receives, and it outputs through the signal selection circuitry 24.

[0011] moreover -- present -- business -- it is also the same as when the optical receiver 22-1 of a system breaks down. In this case, the lightwave signal received by the optical receiver 22-1 with the wavelength separation means 21 of the wavelength multiplexing receiving means 20 may be changed to the optical receiver 23-1 of a reserve system, and you may make it make the optical receiver 23-1 of a reserve system receive by changing the wavelength of that lightwave signal with the wavelength multiplexing transmitting means 10.

[0012] drawing 1 (c) present -- business -- the optical transmission line 52-1 of a system breaks down, and the condition of changing and applying to the optical transmission line 52-2 of a reserve system is shown. Namely, the wavelength multiplexing means 14 of the wavelength multiplexing transmitting means 10 carries out wavelength multiplexing of the lightwave signal outputted from the optical transmitter 12-1 - 12-m, and sends it out to an optical transmission line 52-2. The wavelength separation means 21 of the wavelength multiplexing receiving means 20 divides into each wavelength the wavelength multiplexing lightwave signal inputted from an optical transmission line 52-2, and connects it to the optical receiver 22-1 - 22-m.

[0013] Thus, it has the reserve system of an optical transmitter and an optical receiver by the n channel, and enables it to correspond to both equipment failure and optical transmission line failure in wavelength multiplex transmission of m channels in the wavelength asynchronous transfer mode device of this invention. The value of this n is decided in the range of m from 1 according to a failure generating situation and a restoration demand. namely, -- present -- business -- it is not necessary to necessarily number[same]-prepare a system and a reserve system, and a reserve system can consist of minimum configurations.

[0014]

[Embodiment of the Invention]

(1st operation gestalt of the wavelength multiplexing transmitting means 10) Drawing 2 indicates the example of a change over optical transmitter failure to be the 1st operation gestalt of the wavelength multiplexing transmitting means 10. Here, the case of m= 3 in the basic configuration of drawing 1 and n= 1 is shown.

[0015] drawing -- setting -- input signals S1, S2, and S3 -- the signal selection circuitry 11 -- minding -- the optical transmitter 12-1 - 12- it is inputted into 3 or 13. It connects with the optical coupler 16-1 or the optical coupler 16-2 through an optical switch 15-1 to 15-4, and the output of each optical transmitter is sent out to an optical transmission line 52-1 or an optical transmission line 52-2.

[0016] At a normal state, it is drawing 2 (a). The signal selection circuitry 11 connects input signals S1, S2, and S3 to the optical transmitter 12-1 to 12-3, through an optical switch 15-1 to 15-3, connects with the optical coupler 16-1, carries out wavelength multiplexing of the lightwave signal of the wavelength lambda1, lambda2, and lambda3 outputted from each optical transmitter, and sends it out to an optical transmission line 52-1 so that it may be shown.

[0017] By the case where the optical transmitter 12-2 breaks down, it is drawing 2 (b). The signal selection circuitry 11 connects an input signal S2 to the optical transmitter 13, through an optical switch 15-1 to 15-4, connects with the optical coupler 16-1, carries out wavelength multiplexing of the lightwave signal of the wavelength lambda1 and lambda3 outputted from each optical transmitter, and lambdaa, and sends it out to an optical transmission line 52-1 so that it may be shown. With this configuration, since an optical switch 15 and the optical coupler 16 do not have a wavelength dependency, wavelength lambdaa of the optical transmitter 13 is arbitrary. In addition, to use the optical multiplexing machine which replaces with the optical coupler 16 and has a wavelength dependency, it is necessary to choose wavelength lambdaa as the wavelength doubled with the optical multiplexing machine.

[0018] (1st operation gestalt of the wavelength multiplexing receiving means 20) Drawing 3 indicates the example of a change over optical transmitter failure of the wavelength multiplexing transmitting means 10 to be the 1st operation gestalt of the wavelength multiplexing receiving means 20 (m= 3, n= 1).

[0019] in drawing, the wavelength multiplexing lightwave signal inputted from an optical transmission line 52-1 or an optical transmission line 52-2 is separated spectrally into the lightwave signal of each wavelength by the optical separator 25-1 and 25-2 -- having -- one [each] lightwave signal -- an optical switch 26-1 to 26-4 -- minding -- the optical receiver 22-1 - 22- it is inputted into 3 and 23. The output of each optical receiver is outputted through the signal selection circuitry 24. In addition, as an optical separator 25, a dielectric multilayers optical filter, the array waveguide diffraction grating (AWG) mentioned later, a fiber grating, an optical circulator, etc. can be used.

[0020] Drawing 3 (a) When the wavelength multiplexing transmitting means 10 is a normal state (drawing 2 (a)), the connection condition of the wavelength multiplexing receiving means 20 is shown. That is, the wavelength multiplexing lightwave signal inputted from an optical transmission line 52-1 is separated spectrally into the lightwave signal of each wavelength with an optical separator 25-1, and the lightwave signal of wavelength lambda1-lambda3 is inputted into the optical receiver 22-1 to 22-3 through an optical switch 26-1 to 26-3. The signal selection circuitry 24 outputs the output signal of the optical receiver 22-1 to 22-3.

[0021] Drawing 3 (b) When the optical transmitter 12-2 of the wavelength multiplexing transmitting means 10 breaks down (drawing 2 (b)), the connection condition of the wavelength multiplexing receiving means 20 is shown. namely, the wavelength multiplexing lightwave signal inputted from an optical transmission line 52-1 -- an optical separator 25-1 -- the lightwave signal of each wavelength -- separating spectrally -- the lightwave signal of wavelength lambda1 and lambda3 and lambdaa -- an optical switch 26-1, 26-3, and 26-4 -- minding -- the optical receiver 22-1 and 22- it inputs into 3 and 23. the signal selection circuitry

24 -- optical receiver 22- the output signal of 1, 23, and 22-3 is outputted. In addition, if wavelength lambdaa of the lightwave signal transmitted from the optical transmitter 13 is lambda 2, it is drawing 3 (a). The configuration of the shown wavelength multiplexing receiving means 20 may be used.

[0022] (Example of a change over optical receiver failure of the wavelength multiplexing receiving means 20) It is as follows when the optical receiver 22-2 of the wavelength multiplexing receiving means 20 breaks down. Drawing 3 (b) In a configuration, the lightwave signal of the wavelength lambda 2 separated spectrally into the optical receiver 22-2 from an optical separator 25-1 is sent out to the spare optical receiver 23. The configuration of the optical separator which makes this possible is drawing 4 (a). It constitutes from an optical splitter 31, an optical filter 32-1 to 32-3, and a transmitted wave length good light variation filter 33, and it adjusts so that the transmitted wave length of the transmitted wave length good light variation filter 33 may be set to lambda 2, so that it may be shown. Or drawing 4 (b) It constitutes from an optical splitter 31 and a transmitted wave length good light variation filter 33-1 to 33-4, and it adjusts so that the transmitted wave length of the transmitted wave length good light variation filter 33-4 may be set to lambda 2, so that it may be shown.

[0023] Or the lightwave signal of wavelength lambdaa is made to transmit from the optical transmitter 13, and you may make it make the optical receiver 23 receive the lightwave signal like the case where the optical transmitter 12-2 of the wavelength multiplexing transmitting means 10 breaks down.

[0024] (2nd operation gestalt of the wavelength multiplexing transmitting means 10) Drawing 5 indicates the example of a change over optical transmitter failure to be the 2nd operation gestalt of the wavelength multiplexing transmitting means 10. Here, the case of m= 3 in the basic configuration of drawing 1 and n= 1 is shown.

[0025] drawing -- setting -- input signals S1, S2, and S3 -- the signal selection circuitry 11 -- minding -- the optical transmitter 12-1 - 12- it is inputted into 3 or 13. It connects with the predetermined input port of the array waveguide diffraction grating (henceforth "AWG") 17, and the output of each optical transmitter is sent out to an optical transmission line 52-1 or an optical transmission line 52-2 from the predetermined output port of AWG17.

[0026] AWG17 is an optical multiplexing machine with the wavelength dependency it is decided according to input port and input wavelength that an output port will be. Here, when the lightwave signal of wavelength lambda1, lambda2, lambda3, and lambda4 is inputted into four input port, the wavelength multiplexing lightwave signal which multiplexed them shall be outputted to the output port connected to an optical transmission line 52-1.

[0027] At a normal state, it is drawing 5 (a). The signal selection circuitry 11 connects input signals S1, S2, and S3 to the optical transmitter 12-1 to 12-3, carries out wavelength multiplexing of the lightwave signal of the wavelength lambda1, lambda2, and lambda3 outputted from each optical transmitter by AWG17, and sends it out to an optical transmission line 52-1 so that it may be shown.

[0028] By the case where the optical transmitter 12-2 breaks down, it is drawing 5 (b). The signal selection circuitry 11 connects an input signal S2 to the optical transmitter 13, carries out wavelength multiplexing of the lightwave signal of the wavelength lambda1, lambda3, and lambda4 outputted from each optical transmitter by AWG17, and sends it out to an optical transmission line 52-1 so that it may be shown. With this configuration, the wavelength of the optical transmitter 13 is limited to lambda 4.

[0029] Moreover, drawing 5 (c) If the lightwave signal of the same wavelength lambda 2 as the optical transmitter 12-2 with which the optical transmitter 13 broke down shall be outputted so that it may be shown, it will change so that the lightwave signal of the wavelength lambda 2 outputted from the optical transmitter 13 through the signal selection circuitry 18 may be connected to the 2nd input port of AWG17. The lightwave signal of wavelength lambda 2 becomes being the same as that of the condition of having been outputted from the optical transmitter 12-2 by this, and it is sent out to an optical transmission line 52-1 from AWG17.
[0030] (2nd operation gestalt of the wavelength multiplexing receiving means 20) Drawing 6 indicates the example of a change over optical transmitter failure of the wavelength multiplexing transmitting means 10 to be the 2nd operation gestalt of the wavelength multiplexing receiving means 20 (m= 3, n= 1).
[0031] in drawing, the wavelength multiplexing lightwave signal inputted from an optical transmission line 52-1 or an optical transmission line 52-2 is inputted into the predetermined input port of AWG27 -- having -- the lightwave signal of each wavelength -- separating spectrally -- the optical receiver 22-1 from a respectively predetermined output port - 22- it is inputted into 3 and 23. The output of each optical receiver is outputted through the signal selection circuitry 24. This AWG27 is operated as an optical separator with a wavelength dependency by replacing the input/output port of AWG17 used for the wavelength multiplexing transmitting means 10.
[0032] Drawing 6 (a) When the wavelength multiplexing transmitting means 10 is a normal state (drawing 5 (a)), the connection condition of the wavelength multiplexing receiving means 20 is shown. That is, the wavelength multiplexing lightwave signal inputted from an optical transmission line 52-1 is separated spectrally into the lightwave signal of each wavelength by AWG27, and the lightwave signal of wavelength lambda1-lambda3 is inputted into the optical receiver 22-1 to 22-3. The signal selection circuitry 24 outputs the output signal of the optical receiver 22-1 to 22-3.
[0033] Drawing 6 (b) When the optical transmitter 12-2 of the wavelength multiplexing transmitting means 10 breaks down (drawing 5 (b)), the connection condition of the wavelength multiplexing receiving means 20 is shown. namely, the wavelength multiplexing lightwave signal inputted from an optical transmission line 52-1 -- AWG27 -- the lightwave signal of each wavelength -- separating spectrally -- the lightwave signal of wavelength lambda1, lambda3, and lambda4 -- the optical receiver 22-1 and 22- it inputs into 3 and 23. the signal selection circuitry 24 -- optical receiver 22- the output signal of 1, 23, and 22-3 is outputted. In addition, drawing 5 (c) When the optical transmitter 12-2 breaks down so that it may be shown, and the lightwave signal of wavelength lambda 2 is transmitted from the optical transmitter 13, it is drawing 6 (a). It can respond with a configuration.
[0034] (Example of a change over optical receiver failure of the wavelength multiplexing receiving means 20) It is as follows when the optical receiver 22-2 of the wavelength multiplexing receiving means 20 breaks down. Drawing 6 (b) The optical transmitter 12-2 of the wavelength multiplexing transmitting means 10 breaks down, and the lightwave signal of wavelength lambda 4 is made to transmit from the optical transmitter 13, and it is made to make the optical receiver 23 receive the lightwave signal in a configuration like the case where the lightwave signal of wavelength lambda 4 is transmitted from the optical transmitter 13. the signal selection circuitry 24 -- optical receiver 22- the output signal of 1, 23, and 22-3 is outputted.
[0035] In the configuration of each operation gestalt of the wavelength multiplexing transmitting means 10 shown above and the wavelength multiplexing receiving means 20, combination with

the wavelength multiplexing receiving means 20 shown in the wavelength multiplexing transmitting means 10 shown in drawing 2 and drawing 6 or combination with the wavelength multiplexing receiving means 20 shown in the wavelength multiplexing transmitting means 10 shown in drawing 5 and drawing 3 is sufficient.

[0036] (Example of a change over optical transmission line failure) Drawing 7 shows the example of a change of the wavelength multiplexing transmitting means 10 against optical transmission line failure. Here, the configuration of the wavelength multiplexing transmitting means 10 is the same as that of drawing 2 (1st operation gestalt). Moreover, although not illustrated, the configuration of the wavelength multiplexing receiving means 20 is the same as that of drawing 3 (1st operation gestalt).

[0037] drawing -- setting -- input signals S1, S2, and S3 -- the signal selection circuitry 11 -- minding -- the optical transmitter 12-1 - 12- it is inputted into 3 or 13. It connects with the optical coupler 16-1 or the optical coupler 16-2 through an optical switch 15-1 to 15-4, and the output of each optical transmitter is sent out to an optical transmission line 52-1 or an optical transmission line 52-2.

[0038] At a normal state, it is drawing 7 (a). The signal selection circuitry 11 connects input signals S1, S2, and S3 to the optical transmitter 12-1 to 12-3, through an optical switch 15-1 to 15-3, connects with the optical coupler 16-1, carries out wavelength multiplexing of the lightwave signal of the wavelength lambda1, lambda2, and lambda3 outputted from each optical transmitter, and sends it out to an optical transmission line 52-1 so that it may be shown.

[0039] By the case where an optical transmission line 52-1 breaks down, it is drawing 7 (b). An optical switch 15-1 to 15-3 connects and carries out wavelength multiplexing of the lightwave signal of the wavelength lambda1, lambda2, and lambda3 outputted from the optical transmitter 12-1 to 12-3 to the optical coupler 16-2, and sends out to an optical transmission line 52-2 so that it may be shown.

[0040] In addition, mutually-independent [of the correspondence to failure of drawing 2 and the optical transmitter-receiver shown in 3 and the correspondence to failure of the optical transmission line shown in drawing 7] is carried out, and it is also possible to combine both. namely, -- present -- the optical transmitter 12-2 of business -- or -- present -- the optical receiver 22-2 of business -- breaking down -- the change to the optical transmitter 13 or the optical receiver 23 -- present -- the optical transmission line 52-1 of business, and the change to the spare optical transmission line 52-2 can respond to coincidence by the signal selection circuitries 11 and 24, the optical switch 15-1 to 15-4, and actuation of 26-1 to 26-4.

[0041] (Example of a change over optical transmission line failure) Drawing 8 shows the example of a change of the wavelength multiplexing transmitting means 10 against optical transmission line failure. Here, the configuration of the wavelength multiplexing transmitting means 10 is the same as that of drawing 5 (2nd operation gestalt). Moreover, although not illustrated, the configuration of the wavelength multiplexing receiving means 20 is the same as that of drawing 6 (2nd operation gestalt).

[0042] drawing -- setting -- input signals S1, S2, and S3 -- the signal selection circuitry 11 -- minding -- the optical transmitter 12-1 - 12- it is inputted into 3 or 13. It connects with the predetermined input port of AWG17, and the output of each optical transmitter is sent out to an optical transmission line 52-1 or an optical transmission line 52-2 from the predetermined output port of AWG17.

[0043] AWG17 is an optical multiplexing machine with the wavelength dependency it is decided according to input port and input wavelength that an output port will be. Here, when the

lightwave signal of wavelength lambda1, lambda2, lambda3, and lambda4 is inputted into four input port, the wavelength multiplexing lightwave signal which multiplexed them shall be outputted to the output port connected to an optical transmission line 52-1. Moreover, when the lightwave signal of wavelength lambda4, lambda1, lambda2, and lambda3 is inputted into four input port, the wavelength multiplexing lightwave signal which multiplexed them shall be outputted to the output port connected to an optical transmission line 52-2.

[0044] At a normal state, it is drawing 8 (a). The signal selection circuitry 11 connects input signals S1, S2, and S3 to the optical transmitter 12-1 to 12-3, carries out wavelength multiplexing of the lightwave signal of the wavelength lambda1, lambda2, and lambda3 outputted from each optical transmitter by AWG17, and sends it out to an optical transmission line 52-1 so that it may be shown.

[0045] By the case where an optical transmission line 52-1 breaks down, it is drawing 8 (b). If the wavelength of the optical transmitter 12-1 to 12-3 is changed to lambda4, lambda1, and lambda2 so that it may be shown, wavelength multiplexing of the lightwave signal outputted from each optical transmitter will be carried out by AWG17, and it will be sent out to an optical transmission line 52-2.

[0046] Moreover, drawing 8 (c) Supposing there is no modification while the wavelength of the optical transmitter 12-1 to 12-3 has been lambda1, lambda2, and lambda3 so that it may be shown, it will change so that the lightwave signal outputted from the optical transmitter 12-1 to 12-3 through the signal selection circuitry 18 may be connected to the 2nd, 3rd, and 4th input port of AWG17. Thereby, the lightwave signal which carried out wavelength multiplexing by AWG17 can be sent out to an optical transmission line 52-2.

[0047] In addition, mutually-independent [of the correspondence to failure of drawing 5 and the optical transmitter-receiver shown in 6 and the correspondence to failure of the optical transmission line shown in drawing 8] is carried out, and it is also possible to combine both. namely, -- present -- the optical transmitter 12-2 of business -- or -- present -- the optical receiver 22-2 of business -- breaking down -- the change to the optical transmitter 13 or the optical receiver 23 -- present -- the optical transmission line 52-1 of business -- breaking down -- the change to the spare optical transmission line 52-2 -- the optical transmitter 12-1 - 12- it can respond to coincidence by actuation of the wavelength of 3 and 13, or the signal selection circuitries 11, 18, and 24.

[0048] (Application to optical branching insertion node equipment) By combining the wavelength multiplexing transmitting means 10 and the wavelength multiplexing receiving means 20 of a wavelength asynchronous transfer mode device of this invention, the optical branching insertion node equipment (henceforth a "node") shown in drawing 9 can be constituted.

[0049] Drawing 9 (a) It sets, the wavelength multiplexing lightwave signal inputted from the optical transmission line 52 is separated spectrally into each wavelength with the wavelength separation means 21 of the wavelength multiplexing receiving means 20, some of the lightwave signals are inputted into the wavelength multiplexing means 14 of the wavelength multiplexing transmitting means 10 as they are, and it sends out to the optical transmission line 52 of the next step. Here, the wavelength separation means 21 is the optical separator 25 shown in drawing 3 and an optical switch 26, or AWG27 shown in drawing 6 . The wavelength multiplexing means 14 is the optical switch 15 shown in drawing 2 and the optical coupler 16, or AWG17 shown in drawing 5 . Such a node 41 is drawing 9 (b). It connects with concatenation through an optical transmission line 52 so that it may be shown, and the wavelength multiplex transmission system

which can perform branching and insertion of the lightwave signal of predetermined wavelength for every node is constituted.
[0050] (Directions of wavelength lambdaa outputted from the optical transmitter 13 of a reserve system) In drawing 2 and 7, the lightwave signal (extra traffic, dummy signal) of wavelength lambdaa is outputted from the optical transmitter 13 of a reserve system, it connects with the optical coupler 16-1 through an optical switch 15-4, and wavelength multiplexing is carried out to the wavelength multiplexing lightwave signal sent out to an optical transmission line 52-1. Thus, termination of the lightwave signal of wavelength lambdaa sent out to the optical transmission line 52-1 is carried out with the optical receiver 23 of the wavelength multiplexing receiving means 20 shown in drawing 3 .
[0051] Moreover, in drawing 5 and 8, the lightwave signal (extra traffic, dummy signal) of wavelength lambda 4 is outputted from the optical transmitter 13 of a reserve system, it inputs into the predetermined input port of AWG17, and wavelength multiplexing is carried out to the wavelength multiplexing lightwave signal sent out to an optical transmission line 52-1. Thus, termination of the lightwave signal of the wavelength lambda 4 sent out to the optical transmission line 52-1 is carried out with the optical receiver 23 of the wavelength multiplexing receiving means 20 shown in drawing 6 .
[0052] Drawing 10 shows the example of the wavelength multiplex transmission structure of a system which connected three nodes in the shape of a ring. It is transmitted to a node 41-2 through the junction optical amplifier 42-1 using the lightwave signal of wavelength lambda 3 from a node 41-1. It is transmitted to a node 41-1 through the junction optical amplifier 42-2 and a node 41-3 using the lightwave signal of wavelength lambda 3 from a node 41-2. At this time, the lightwave signal of wavelength lambda 3 is passed as it is by the node 41-3.
[0053] It is transmitted to a node 41-3 through the junction optical amplifier 42-2 using the lightwave signal of wavelength lambda 1 from a node 41-2. It is transmitted to a node 41-2 through a node 41-1 and the junction optical amplifier 42-1 using the lightwave signal of wavelength lambda 1 from a node 41-3. At this time, the lightwave signal of wavelength lambda 1 is passed as it is by the node 41-1.
[0054] It is transmitted to a node 41-1 using the lightwave signal of wavelength lambda 2 from a node 41-3. It is transmitted to a node 41-3 through the junction optical amplifier 42-1, a node 41-2, and the junction optical amplifier 42-2 using the lightwave signal of wavelength lambda 2 from a node 41-1. At this time, the lightwave signal of wavelength lambda 2 is passed as it is by the node 41-2.
[0055] Here, between each node, lambdaa is prepared as reserve wavelength. As mentioned above, it is transmitted from each node and termination of this lightwave signal is carried out by the following node. Therefore, the junction optical amplifier 42-1, the gain control of 42-2, an output light level control, or its both can be performed using the lightwave signal of this wavelength lambdaa. That is, in each junction optical amplifier, since what is necessary is just to carry out the monitor of the one wavelength, gain control etc. can be performed in a comparatively easy circuit.
[0056] In addition, in failure occurring in the optical transmitter-receiver of the lightwave signal of the wavelength lambda 2 transmitted to a node 41-3 from a node 41-1 and changing to the lightwave signal of wavelength lambdaa, the lightwave signal of wavelength lambdaa which controlled so that the lightwave signal of wavelength lambdaa passed by the node 41-2, or once carried out termination is again turned to a node 41-3, and it makes it transmit in the wavelength multiplex transmission system shown in drawing 10 .

[0057]
[Effect of the Invention] As explained above, the wavelength asynchronous transfer mode device of this invention can realize a reserve system [as opposed to equipment failure and optical transmission line failure for the reserve of the optical receiver which constitutes the optical transmitter and the wavelength multiplexing receiving means of constituting a wavelength multiplexing transmitting means] by necessary minimum preparation ******. Thereby, the cost reduction for a doubleness configuration becomes possible.
[0058] Furthermore, in the wavelength multiplex transmission system of this invention, the various control between wavelength asynchronous transfer mode devices is realizable using the lightwave signal of a reserve system.

[Translation done.]

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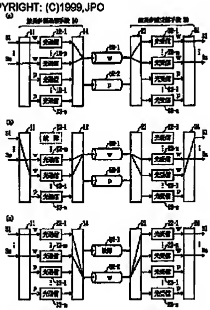
(54) **DEVICE AND SYSTEM FOR MULTIPLEX WAVELENGTH TRANSMISSION**

(57) Abstract:

PROBLEM TO BE SOLVED: To attain cost down for duplex configuration by irreducibly minimizing the spares of optical receivers.

SOLUTION: When any fault occurs at an optical transmitter 12-1 of an active system, a signal selector circuit 11 of a multiplex wavelength transmitting means 10 switches a signal S1 from the optical transmitter 12-1 to 13-1, and a multiplex wavelength multiplexing, means 13 sends the optical signals of optical transmitters 12-2 to 12-m and 13-1 to an optical transmission line 52-1 while multiplexing their wavelengths. At a multiplex wavelength receiving means 20, the signal is received by an optical receiver 22-1 or a reserve system optical receiver 23-1 with the wavelength from the spare system optical transmitter 13-1 and outputs it through a signal selector circuit 24. Besides, when any fault occurs at an active system optical transmission line 52-1, the wavelength multiplexing means 14 of the multiplex wavelength transmitting means 10 sends optical signals outputted from the optical transmitters 12-1 to 12-m to an optical transmission line 52-2 while multiplexing their wavelengths, and a wavelength demultiplexing means 21 of the multiplex wavelength receiving means 20 connects the wavelength multiplexed optical signal inputted to the optical transmission line 52-2 to optical receivers 22-1 to 22-m while demultiplexing the respective wavelengths. Thus, the spare optical transmitter/receiver systems are provided for (n) channels in the transmission of wavelength multiplexed for (m) channels, device and transmission line faults are dealt with.



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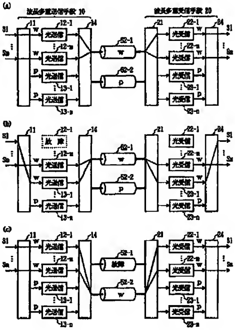
(54)【発明の名称】　波長多重伝送装置および波長多重伝送システム

(57)【要約】

【課題】　最小限の機器で予備系を構成し、二重化構成のためのコストを低減する。

【解決手段】　波長多重送信手段は、m個（mは2以上の整数）の入力信号S1～Smに対して、（m＋n）個（nは1以上m以下の整数）の出力方路を選択可能な信号選択回路と、光源波長が互いに異なるm個の光送信器およびn個の光送信器と、各波長の光信号を波長多重して光伝送路に送出する波長多重手段により構成する。波長多重受信手段は、光伝送路から入力される波長多重光信号を各波長に分波する波長分離手段と、各波長の光信号を受信するm個の光受信器およびn個の光受信器と、（m＋n）個の入力信号に対してm個の出力方路を選択可能な信号選択回路により構成する。

本発明の波長多重伝送装置の基本構成および切替例



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【特許請求の範囲】

【請求項1】　現用光伝送路または予備光伝送路を介して、波長多重光信号を送受信する波長多重送信手段および波長多重受信手段を備えた波長多重伝送装置において、

前記波長多重送信手段は、

m個（mは2以上の整数）の入力信号に対して（m＋n）個（nは1以上m以下の整数）の出力方路を選択可能な信号選択回路と、

前記信号選択回路の各出力端子に接続され、その出力信号に応じて互いに異なる波長の光信号を出力するm個の現用光送信器およびn個の予備光送信器と、

前記現用光送信器および前記予備光送信器から出力される光信号を波長多重し、前記現用光伝送路または前記予備光伝送路に出力する波長多重手段とを備えたことを特徴とする波長多重伝送装置。

【請求項2】　請求項1に記載の波長多重伝送装置において、

信号選択回路は、通常時にm個の入力信号をm個の現用光送信器に接続し、前記m個の現用光送信器のうちi個（iは1以上n以下の整数）を予備光送信器に切り替えるときに、その現用光送信器に接続していた入力信号をi個の予備光送信器に切り替える構成であることを特徴とする波長多重伝送装置。

【請求項3】　請求項1に記載の波長多重伝送装置において、

波長多重手段は、通常時に現用光送信器から出力される光信号を波長多重して光伝送路に出力し、現用光送信器の一部に代えて予備光送信器を用いたときに、対応する現用光送信器および予備光送信器から出力される光信号を波長多重して光伝送路に出力する構成であることを特徴とする波長多重伝送装置。

【請求項4】　請求項3に記載の波長多重伝送装置において、

波長多重手段は、入力ポートと入力波長に応じて出力ポートが決まる波長依存性を有し、

現用光送信器の一部に代えて予備光送信器を用いたときに、その予備光送信器から出力された光信号が接続される前記波長多重手段の入力ポートを切り替える信号選択回路を備えたことを特徴とする波長多重伝送装置。

【請求項5】　現用光伝送路または予備光伝送路を介して、波長多重光信号を送受信する波長多重送信手段および波長多重受信手段を備えた波長多重伝送装置において、

前記波長多重受信手段は、

前記現用光伝送路または前記予備光伝送路から入力される波長多重光信号を各波長の光信号に分離する波長分離手段と、

前記波長分離手段の各出力端子に接続され、各出力端子に対応する各波長の光信号を受信するm個（mは2以上

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の整数）の現用光受信器およびn個（nは1以上m以下の整数）の予備光受信器と、

前記m個の現用光受信器および前記n個の予備光受信器から出力される（m＋n）個の入力信号に対してm個の出力方路を選択可能な信号選択回路とを備えたことを特徴とする波長多重伝送装置。

【請求項6】　請求項5に記載の波長多重伝送装置において、

信号選択回路は、通常時にm個の現用光受信器の出力信号を出力し、前記m個の現用光受信器のうちi個（iは1以上n以下の整数）を予備光受信器に切り替えるときに、その現用光受信器の出力信号を予備光受信器の出力信号に切り替えて出力する構成であることを特徴とする波長多重伝送装置。

【請求項7】　請求項5に記載の波長多重伝送装置において、

波長分離手段は、通常時に現用光伝送路からの波長多重光信号を各波長に分波して現用光受信器に入力し、現用光送信器の一部に代えて予備光送信器を用いたときに、または現用光受信器の一部に代えて予備光受信器を用いたときに、現用光伝送路から入力される波長多重光信号を各波長に分波し、それぞれ対応する現用光受信器および予備光受信器に入力する構成であることを特徴とする波長多重伝送装置。

【請求項8】　光伝送路から入力される波長多重光信号を受信する請求項5に記載の波長多重受信手段と、光伝送路に出力する波長多重光信号を送信する請求項1に記載の波長多重送信手段とを備えた複数の波長多重伝送装置と、各波長多重伝送装置間に配置される1以上の中継光増幅器とを縦続に接続した波長多重伝送システムにおいて、

各波長多重伝送装置間で予備光送信器から予備光受信器に伝送される光信号の波長（予備波長）を同一とする構成であることを特徴とする波長多重伝送システム。

【請求項9】　請求項8に記載の波長多重伝送システムにおいて、

各波長多重伝送装置間で予備波長の光信号をモニタし、中継光増幅器の利得制御または出力光レベル制御またはその両方の制御に供する構成であることを特徴とする波長多重伝送システム。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、現用系と予備系を備えた波長多重伝送装置およびそれを縦続に接続した波長多重伝送システムに関する。特に、波長多重光信号を送受信する装置の故障、または波長多重光信号を伝送する光伝送路の故障に対して、現用系から予備系への切り替えにより故障復旧を行うための構成に関する。

【0002】

【従来の技術】図11は、現用系と予備系を備えた従来

の波長多重伝送装置の構成例を示す。図において、波長多重送信手段５１－１，５１－２、光伝送路５２－１，５２－２、波長多重受信手段５３－１，５３－２は、それぞれ現用系および予備系として独立に配置される。波長多重送信手段５１－１，５１－２は、光源波長が互いに異なるｎ個の光送信器５４と、各波長の光信号を波長多重して光伝送路５２－１，５２－２に送出する光合波器５５により構成される。波長多重受信手段５３－１，５３－２は、光伝送路５２－１，５２－２から入力される波長多重光信号を各波長に分波する光分波器５６と、各波長の光信号を受信するｎ個の光受信器５７により構成される。ここで、現用系のチャネルをｗ、予備系のチャネルをｐで示す。

【０００３】

【発明が解決しようとする課題】従来の波長多重伝送装置では、装置故障または光伝送路故障に対して、現用系から予備系に切り替えることにより故障復旧させる構成になっている。このときの問題点について、図１２を参照して説明する。ここでは、２チャネル多重構成について示す。

【０００４】図１２(a) に示すように、現用系の波長多重送信手段５１－１の１チャネルが故障したときに、図１２(c) に示すようにその１チャネルのみを予備系の波長多重送信手段５１－２に切り替えると、両方の光伝送路５２－１，５２－２が現用系となってしまう。このような状況は、システムの保守・運用上混乱の原因となり好ましくない。それを避けるためには、１チャネルの故障の場合でも、図１２(d) に示すように全チャネルを一括して予備系に切り替え、片系のみで運用するようにする。また、図１２(b) に示すように、現用系の光伝送路５２－１が故障した場合には、図１２(d) に示すように全チャネルを一括して予備系に切り替える。

【０００５】このように、従来の波長多重伝送装置は、波長多重送信手段、光伝送路、波長多重受信手段のすべてについて、現用系の他に予備系を備えた構成になっている。そのため、特に光送信器および光受信器がチャネル数の２倍必要となり、波長多重伝送装置のコスト上昇の要因になっていた。

【０００６】本発明は、最小限の機器で予備系を構成し、二重化構成のためのコストを低減することができる波長多重伝送装置および波長多重伝送システムを提供することを目的とする。

【０００７】

【課題を解決するための手段】図１は、本発明の波長多重伝送装置の基本構成および切替例を示す。図において、波長多重送信手段１０は、ｍ個（ｍは２以上の整数）の入力信号Ｓ１～Ｓｍに対して、（ｍ＋ｎ）個（ｎは１以上ｍ以下の整数）の出力方路を選択可能な信号選択回路１１と、光源波長が互いに異なるｍ個の光送信器１２－１～１２－ｍおよびｎ個の光送信器１３－１～１３－ｎと、各波長の光信号を波長多重して光伝送路５２－１または光伝送路５２－２に送出する波長多重手段１４により構成される。波長多重受信手段２０は、光伝送路５２－１または光伝送路５２－２から入力される波長多重光信号を各波長に分波する波長分離手段２１と、各波長の光信号を受信するｍ個の光受信器２２－１～２２－ｍおよびｎ個の光受信器２３－１～２３－ｎと、（ｍ＋ｎ）個の入力信号に対してｍ個の出力方路を選択可能な信号選択回路２４により構成される。ここで、現用系のチャネルをｗ、予備系のチャネルをｐで示す。

【０００８】図１(a) は、光送信器１２－１～１２－ｍ、光伝送路５２－１、光受信器２２－１～２２－ｍを現用系とし、光送信器１３－１～１３－ｎ、光伝送路５２－２、光受信器２３－１～２３－ｎを予備系として運用する通常状態を示す。すなわち、波長多重送信手段１０の信号選択回路１１はｍ個の入力信号Ｓ１～Ｓｍを光送信器１２－１～１２－ｍに接続し、波長多重手段１４は光送信器１２－１～１２－ｍから出力される光信号を波長多重して光伝送路５２－１に送出する。波長多重受信手段２０の波長分離手段２１は、光伝送路５２－１から入力される波長多重光信号を各波長に分離して光受信器２２－１～２２－ｍに接続し、その受信信号が信号選択回路２４を介して出力される。

【０００９】図１(b) は、現用系の光送信器１２－１が故障し、予備系の光送信器１３－１に切り替えて運用する状態を示す。すなわち、波長多重送信手段１０の信号選択回路１１は、光送信器１２－１に接続していた入力信号Ｓ１を光送信器１３－１に切り替え、波長多重手段１４は光送信器１２－２～１２－ｍ，１３－１から出力される光信号を波長多重して光伝送路５２－１に送出する。このとき、予備系の光送信器１３－１から送信される光信号の波長は、故障した光送信器１２－１と同一波長または他の波長に設定される。

【００１０】波長多重受信手段２０では、予備系の光送信器１３－１から送信される光信号の波長に応じて、光受信器２２－１で受信するか、または図に示すように予備系の光受信器２３－１で受信し、信号選択回路２４を介して出力する。

【００１１】また、現用系の光受信器２２－１が故障した場合も同様である。この場合には、波長多重受信手段２０の波長分離手段２１で光受信器２２－１に受信される光信号を予備系の光受信器２３－１に切り替えてもよいし、波長多重送信手段１０でその光信号の波長を切り替えることにより予備系の光受信器２３－１に受信させるようにしてもよい。

【００１２】図１(c) は、現用系の光伝送路５２－１が故障し、予備系の光伝送路５２－２に切り替えて運用する状態を示す。すなわち、波長多重送信手段１０の波長多重手段１４は光送信器１２－１～１２－ｍから出力される光信号を波長多重して光伝送路５２－２に送出す

る。波長多重受信手段２０の波長分離手段２１は、光伝送路５２－２から入力される波長多重光信号を各波長に分離して光受信器２２－１～２２－mに接続する。

【００１３】このように、本発明の波長多重伝送装置では、mチャネルの波長多重伝送において、光送信器および光受信器の予備系をnチャネル分備え、装置故障と光伝送路故障の両方に対応できるようにしたものである。このnの値は、故障発生状況と復旧要求に応じて１からmの範囲で決められる。すなわち、現用系と予備系を必ずしも同一数用意する必要はなく、最小限の構成で予備系を構成することができる。

【００１４】

【発明の実施の形態】

（波長多重送信手段１０の第１の実施形態）図２は、波長多重送信手段１０の第１の実施形態と、光送信器故障に対する切替例を示す。ここでは、図１の基本構成におけるm＝３、n＝１の場合について示す。

【００１５】図において、入力信号Ｓ１，Ｓ２，Ｓ３は、信号選択回路１１を介して光送信器１２－１～１２－３，１３のいずれかに入力される。各光送信器の出力は、光スイッチ１５－１～１５－４を介して光カプラ１６－１または光カプラ１６－２に接続され、光伝送路５２－１または光伝送路５２－２に送出される。

【００１６】通常状態では、図２(a) に示すように、信号選択回路１１は入力信号Ｓ１，Ｓ２，Ｓ３を光送信器１２－１～１２－３に接続し、各光送信器から出力される波長λ１，λ２，λ３の光信号を光スイッチ１５－１～１５－３を介して光カプラ１６－１に接続し、波長多重して光伝送路５２－１に送出する。

【００１７】光送信器１２－２が故障した場合では、図２(b) に示すように、信号選択回路１１は入力信号Ｓ２を光送信器１３に接続し、各光送信器から出力される波長λ１，λ３，λａの光信号を光スイッチ１５－１～１５－４を介して光カプラ１６－１に接続し、波長多重して光伝送路５２－１に送出する。本構成では、光スイッチ１５および光カプラ１６は波長依存性がないので、光送信器１３の波長λａは任意である。なお、光カプラ１６に代えて波長依存性のある光合波器を用いる場合には、波長λａはその光合波器に合わせた波長に選ぶ必要がある。

【００１８】（波長多重受信手段２０の第１の実施形態）図３は、波長多重受信手段２０の第１の実施形態と、波長多重送信手段１０の光送信器故障に対する切替例を示す（m＝３、n＝１）。

【００１９】図において、光伝送路５２－１または光伝送路５２－２から入力される波長多重光信号は、光分波器２５－１，２５－２で各波長の光信号に分波され、それぞれの一方の光信号が光スイッチ２６－１～２６－４を介して光受信器２２－１～２２－３，２３に入力される。各光受信器の出力は、信号選択回路２４を介して出力される。なお、光分波器２５としては、誘電体多層膜光フィルタ、後述するアレイ導波路回折格子（ＡＷＧ）、ファイバグレーティングと光サーキュレータなどを用いることができる。

【００２０】図３(a) は、波長多重送信手段１０が通常状態の場合（図２(a)）に対応する波長多重受信手段２０の接続状態を示す。すなわち、光伝送路５２－１から入力される波長多重光信号を光分波器２５－１で各波長の光信号に分波し、波長λ１～λ３の光信号を光スイッチ２６－１～２６－３を介して光受信器２２－１～２２－３に入力する。信号選択回路２４は、光受信器２２－１～２２－３の出力信号を出力する。

【００２１】図３(b) は、波長多重送信手段１０の光送信器１２－２が故障した場合（図２(b)）に対応する波長多重受信手段２０の接続状態を示す。すなわち、光伝送路５２－１から入力される波長多重光信号を光分波器２５－１で各波長の光信号に分波し、波長λ１，λ３，λａの光信号を光スイッチ２６－１，２６－３，２６－４を介して光受信器２２－１，２２－３，２３に入力する。信号選択回路２４は、光受信器２２－１，２３，２２－３の出力信号を出力する。なお、光送信器１３から送信される光信号の波長λａがλ２であれば、図３(a) に示す波長多重受信手段２０の構成でもよい。

【００２２】（波長多重受信手段２０の光受信器故障に対する切替例）波長多重受信手段２０の光受信器２２－２が故障した場合には、次のようになる。図３(b) の構成において、光分波器２５－１から光受信器２２－２に分波する波長λ２の光信号を予備の光受信器２３に送出する。これを可能にする光分波器の構成は、図４(a) に示すように、光スプリッタ３１と光フィルタ３２－１～３２－３と透過波長可変光フィルタ３３で構成し、透過波長可変光フィルタ３３の透過波長がλ２になるように調整する。または、図４(b) に示すように、光スプリッタ３１と透過波長可変光フィルタ３３－１～３３－４で構成し、透過波長可変光フィルタ３３－４の透過波長がλ２になるように調整する。

【００２３】または、波長多重送信手段１０の光送信器１２－２が故障した場合と同様に、光送信器１３から波長λａの光信号を送信させ、その光信号を光受信器２３に受信させるようにしてもよい。

【００２４】（波長多重送信手段１０の第２の実施形態）図５は、波長多重送信手段１０の第２の実施形態と、光送信器故障に対する切替例を示す。ここでは、図１の基本構成におけるm＝３、n＝１の場合について示す。

【００２５】図において、入力信号Ｓ１，Ｓ２，Ｓ３は、信号選択回路１１を介して光送信器１２－１～１２－３，１３のいずれかに入力される。各光送信器の出力は、アレイ導波路回折格子（以下「ＡＷＧ」という）１７の所定の入力ポートに接続され、ＡＷＧ１７の所定の

出力ポートから光伝送路５２－１または光伝送路５２－２に送出される。

【００２６】ＡＷＧ１７は、入力ポートと入力波長に応じて出力ポートが決まる波長依存性のある光合波器である。ここでは、４つの入力ポートに波長λ１，λ２，λ３，λ４の光信号が入力されたときに、それらを合波した波長多重光信号が光伝送路５２－１に接続される出力ポートに出力されるものとする。

【００２７】通常状態では、図５(a) に示すように、信号選択回路１１は入力信号Ｓ１，Ｓ２，Ｓ３を光送信器１２－１～１２－３に接続し、各光送信器から出力される波長λ１，λ２，λ３の光信号をＡＷＧ１７で波長多重して光伝送路５２－１に送出する。

【００２８】光送信器１２－２が故障した場合では、図５(b) に示すように、信号選択回路１１は入力信号Ｓ２を光送信器１３に接続し、各光送信器から出力される波長λ１，λ３，λ４の光信号をＡＷＧ１７で波長多重して光伝送路５２－１に送出する。本構成では、光送信器１３の波長はλ４に限定される。

【００２９】また、図５(c) に示すように、光送信器１３が故障した光送信器１２－２と同じ波長λ２の光信号を出力するものとすると、信号選択回路１８を介して光送信器１３から出力された波長λ２の光信号がＡＷＧ１７の第２の入力ポートに接続されるように切り替える。これにより、波長λ２の光信号が光送信器１２－２から出力された状態と同様になり、ＡＷＧ１７から光伝送路５２－１に送出される。

【００３０】（波長多重受信手段２０の第２の実施形態）図６は、波長多重受信手段２０の第２の実施形態と、波長多重送信手段１０の光送信器故障に対する切替例を示す（ｍ＝３、ｎ＝１）。

【００３１】図において、光伝送路５２－１または光伝送路５２－２から入力される波長多重光信号は、ＡＷＧ２７の所定の入力ポートに入力され、各波長の光信号に分波してそれぞれ所定の出力ポートから光受信器２２－１～２２－３，２３に入力される。各光受信器の出力は、信号選択回路２４を介して出力される。このＡＷＧ２７は、波長多重送信手段１０に用いたＡＷＧ１７の入出力ポートを入れ替えることにより、波長依存性のある光分波器として機能させたものである。

【００３２】図６(a) は、波長多重送信手段１０が通常状態の場合（図５(a)）に対応する波長多重受信手段２０の接続状態を示す。すなわち、光伝送路５２－１から入力される波長多重光信号をＡＷＧ２７で各波長の光信号に分波し、波長λ１～λ３の光信号を光受信器２２－１～２２－３に入力する。信号選択回路２４は、光受信器２２－１～２２－３の出力信号を出力する。

【００３３】図６(b) は、波長多重送信手段１０の光送信器１２－２が故障した場合（図５(b)）に対応する波長多重受信手段２０の接続状態を示す。すなわち、光伝送路５２－１から入力される波長多重光信号をＡＷＧ２７で各波長の光信号に分波し、波長λ１，λ３，λ４の光信号を光受信器２２－１，２２－３，２３に入力する。信号選択回路２４は、光受信器２２－１，２３，２２－３の出力信号を出力する。なお、図５(c) に示すように光送信器１２－２が故障し、光送信器１３から波長λ２の光信号が送信される場合には、図６(a) の構成で対応することができる。

【００３４】（波長多重受信手段２０の光受信器故障に対する切替例）波長多重受信手段２０の光受信器２２－２が故障した場合には、次のようになる。図６(b) の構成において、波長多重送信手段１０の光送信器１２－２が故障し、光送信器１３から波長λ４の光信号が送信される場合と同様に、光送信器１３から波長λ４の光信号を送信させ、その光信号を光受信器２３に受信させるようにする。信号選択回路２４は、光受信器２２－１，２３，２２－３の出力信号を出力する。

【００３５】以上示した波長多重送信手段１０および波長多重受信手段２０の各実施形態の構成において、図２に示す波長多重送信手段１０と図６に示す波長多重受信手段２０との組み合わせ、あるいは図５に示す波長多重送信手段１０と図３に示す波長多重受信手段２０との組み合わせでもよい。

【００３６】（光伝送路故障に対する切替例）図７は、光伝送路故障に対する波長多重送信手段１０の切替例を示す。ここでは、波長多重送信手段１０の構成は図２（第１の実施形態）と同様である。また、図示しないが、波長多重受信手段２０の構成は図３（第１の実施形態）と同様である。

【００３７】図において、入力信号Ｓ１，Ｓ２，Ｓ３は、信号選択回路１１を介して光送信器１２－１～１２－３，１３のいずれかに入力される。各光送信器の出力は、光スイッチ１５－１～１５－４を介して光カプラ１６－１または光カプラ１６－２に接続され、光伝送路５２－１または光伝送路５２－２に送出される。

【００３８】通常状態では、図７(a) に示すように、信号選択回路１１は入力信号Ｓ１，Ｓ２，Ｓ３を光送信器１２－１～１２－３に接続し、各光送信器から出力される波長λ１，λ２，λ３の光信号を光スイッチ１５－１～１５－３を介して光カプラ１６－１に接続し、波長多重して光伝送路５２－１に送出する。

【００３９】光伝送路５２－１が故障した場合では、図７(b) に示すように、光スイッチ１５－１～１５－３が光送信器１２－１～１２－３から出力される波長λ１，λ２，λ３の光信号を光カプラ１６－２に接続し、波長多重して光伝送路５２－２に送出する。

【００４０】なお、図２，３に示す光送受信器の故障への対応と、図７に示す光伝送路の故障への対応は互いに独立しており、両者を組み合わせることも可能である。すなわち、現用の光送信器１２－２または現用の光受信

器２２－２が故障し、光送信器１３または光受信器２３への切り替えと、現用の光伝送路５２－１が故障して予備の光伝送路５２－２への切り替えは、信号選択回路１１，２４と光スイッチ１５－１～１５－４，２６－１～２６－４の操作により同時に対応することができる。

【００４１】（光伝送路故障に対する切替例）図８は、光伝送路故障に対する波長多重送信手段１０の切替例を示す。ここでは、波長多重送信手段１０の構成は図５（第２の実施形態）と同様である。また、図示しないが、波長多重受信手段２０の構成は図６（第２の実施形態）と同様である。

【００４２】図において、入力信号Ｓ１，Ｓ２，Ｓ３は、信号選択回路１１を介して光送信器１２－１～１２－３，１３のいずれかに入力される。各光送信器の出力は、ＡＷＧ１７の所定の入力ポートに接続され、ＡＷＧ１７の所定の出力ポートから光伝送路５２－１または光伝送路５２－２に送出される。

【００４３】ＡＷＧ１７は、入力ポートと入力波長に応じて出力ポートが決まる波長依存性のある光合波器である。ここでは、４つの入力ポートに波長λ１，λ２，λ３，λ４の光信号が入力されたときに、それらを合波した波長多重光信号が光伝送路５２－１に接続される出力ポートに出力されるものとする。また、４つの入力ポートに波長λ４，λ１，λ２，λ３の光信号が入力されたときに、それらを合波した波長多重光信号が光伝送路５２－２に接続される出力ポートに出力されるものとする。

【００４４】通常状態では、図８(a) に示すように、信号選択回路１１は入力信号Ｓ１，Ｓ２，Ｓ３を光送信器１２－１～１２－３に接続し、各光送信器から出力される波長λ１，λ２，λ３の光信号をＡＷＧ１７で波長多重して光伝送路５２－１に送出する。

【００４５】光伝送路５２－１が故障した場合では、図８(b) に示すように、光送信器１２－１～１２－３の波長をλ４，λ１，λ２に切り替えると、各光送信器から出力される光信号はＡＷＧ１７で波長多重して光伝送路５２－２に送出される。

【００４６】また、図８(c) に示すように、光送信器１２－１～１２－３の波長がλ１，λ２，λ３のままで変更がないとすると、信号選択回路１８を介して光送信器１２－１～１２－３から出力された光信号をＡＷＧ１７の第２，第３，第４の入力ポートに接続されるように切り替える。これにより、ＡＷＧ１７で波長多重した光信号を光伝送路５２－２に送出することができる。

【００４７】なお、図５，６に示す光送受信器の故障への対応と、図８に示す光伝送路の故障への対応は互いに独立しており、両者を組み合わせることも可能である。すなわち、現用の光送信器１２－２または現用の光受信器２２－２が故障し、光送信器１３または光受信器２３への切り替えと、現用の光伝送路５２－１が故障して予備の光伝送路５２－２への切り替えは、光送信器１２－１～１２－３，１３の波長または信号選択回路１１，１８，２４の操作により同時に対応することができる。

【００４８】（光分岐挿入ノード装置への応用例）本発明の波長多重伝送装置の波長多重送信手段１０と波長多重受信手段２０を組み合わせることにより、図９に示す光分岐挿入ノード装置（以下「ノード」という）を構成することができる。

【００４９】図９(a) において、光伝送路５２から入力された波長多重光信号を波長多重受信手段２０の波長分離手段２１で各波長に分波し、その一部の光信号をそのまま波長多重送信手段１０の波長多重手段１４に入力し、次段の光伝送路５２に送出する。ここで、波長分離手段２１は、図３に示す光分波器２５および光スイッチ２６、または図６に示すＡＷＧ２７である。波長多重手段１４は、図２に示す光スイッチ１５および光カプラ１６、または図５に示すＡＷＧ１７である。このようなノード４１は、図９(b) に示すように光伝送路５２を介して縦続に接続され、ノードごとに所定の波長の光信号の分岐・挿入ができる波長多重伝送システムが構成される。

【００５０】（予備系の光送信器１３から出力される波長λａの利用法）図２，７において、予備系の光送信器１３から波長λａの光信号（エキストラトラヒック、ダミー信号）を出力し、光スイッチ１５－４を介して光カプラ１６－１に接続し、光伝送路５２－１に送出される波長多重光信号に波長多重する。このようにして光伝送路５２－１に送出された波長λａの光信号は、図３に示す波長多重受信手段２０の光受信器２３で終端される。

【００５１】また、図５，８において、予備系の光送信器１３から波長λ４の光信号（エキストラトラヒック、ダミー信号）を出力し、ＡＷＧ１７の所定の入力ポートに入力し、光伝送路５２－１に送出される波長多重光信号に波長多重する。このようにして光伝送路５２－１に送出された波長λ４の光信号は、図６に示す波長多重受信手段２０の光受信器２３で終端される。

【００５２】図１０は、３つのノードをリング状に接続した波長多重伝送システムの構成例を示す。ノード４１－１からノード４１－２へは、波長λ３の光信号を用い、中継光増幅器４２－１を介して伝送される。ノード４１－２からノード４１－１へは、波長λ３の光信号を用い、中継光増幅器４２－２およびノード４１－３を介して伝送される。このとき、ノード４１－３では、波長λ３の光信号をそのまま通過させる。

【００５３】ノード４１－２からノード４１－３へは、波長λ１の光信号を用い、中継光増幅器４２－２を介して伝送される。ノード４１－３からノード４１－２へは、波長λ１の光信号を用い、ノード４１－１および中継光増幅器４２－１を介して伝送される。このとき、ノード４１－１では、波長λ１の光信号をそのまま通過さ

せる。

【0054】ノード41－3からノード41－1へは、波長λ2の光信号を用いて伝送される。ノード41－1からノード41－3へは、波長λ2の光信号を用い、中継光増幅器42－1、ノード41－2および中継光増幅器42－2を介して伝送される。このとき、ノード41－2では、波長λ2の光信号をそのまま通過させる。

【0055】ここで、各ノード間には、予備波長としてλaが用意されている。この光信号は、上述したように各ノードから送信されて次のノードで終端される。したがって、この波長λaの光信号を用いて、中継光増幅器42－1，42－2の利得制御または出力光レベル制御またはその両方を行うことができる。すなわち、各中継光増幅器では、1つの波長をモニタするだけでよいので、比較的簡単な回路で利得制御等を行うことができる。

【0056】なお、図10に示す波長多重伝送システムにおいて、例えばノード41－1からノード41－3へ伝送される波長λ2の光信号の光送受信器に故障が発生し、波長λaの光信号に切り替える場合には、ノード41－2で波長λaの光信号が通過するように制御するか、一旦終端した波長λaの光信号を再度ノード41－3に向けて送信するようにする。

【0057】

【発明の効果】以上説明したように、本発明の波長多重伝送装置は、波長多重送信手段を構成する光送信器および波長多重受信手段を構成する光受信器の予備を必要最小限備えることにより、装置故障および光伝送路故障に対する予備系を実現することができる。これにより、二重化構成のためのコスト低減が可能になる。

【0058】さらに、本発明の波長多重伝送システムでは、予備系の光信号を用いて波長多重伝送装置間の各種制御を実現することができる。

【図面の簡単な説明】

【図1】本発明の波長多重伝送装置の基本構成および切替例を示す図。

【図2】波長多重送信手段10の第1の実施形態と、光送信器故障に対する切替例を示す図。

【図3】波長多重受信手段20の第1の実施形態と切替例を示す図。

【図4】波長多重受信手段20の第1の実施形態における光分波器の構成例を示す図。

【図5】波長多重送信手段10の第2の実施形態と切替例を示す図。

【図6】波長多重受信手段20の第2の実施形態と切替例を示す図。

【図7】光伝送路故障に対する波長多重送信手段10の切替例を示す図。

【図8】光伝送路故障に対する波長多重送信手段10の切替例を示す図。

【図9】光分岐挿入ノード装置の構成例を示す図。

【図10】3つのノードをリング状に接続した波長多重伝送システムの構成例を示す図。

【図11】現用系と予備系を備えた従来の波長多重伝送装置の構成例を示す図。

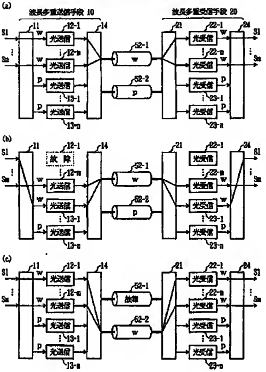
【図12】従来の波長多重伝送装置の問題点を説明する図。

【符号の説明】

10　波長多重送信手段
11　信号選択回路
12，13　光送信器
14　波長多重手段
15　光スイッチ
16　光カプラ
17　アレイ導波路回折格子（AWG）
18　信号選択回路
20　波長多重受信手段
21　波長分離手段
22，23　光受信器
24　信号選択回路
25　光分波器
26　光スイッチ
27　アレイ導波路回折格子（AWG）
31　光スプリッタ
32　光フィルタ
33　透過波長可変光フィルタ
51　波長多重送信手段
52　光伝送路
53　波長多重受信手段
54　光送信器
55　光合波器
56　光分波器
57　光受信器

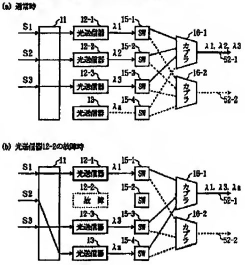
【図１】

本発明の波長多重伝送装置の基本構成および切替例



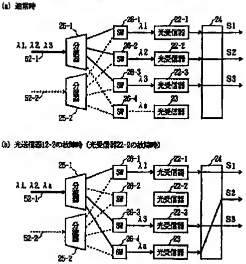
【図２】

波長多重送信手段10の第１の実施形態と切替例



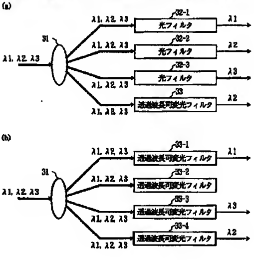
【図３】

波長多重受信手段20の第１の実施形態と切替例



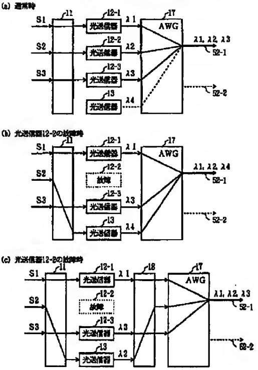
【図４】

波長多重受信手段20の第１の実施形態における光分波器の構成例



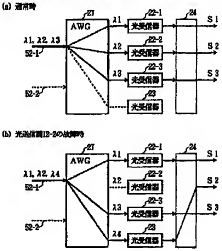
【図5】

波長多重送信手段10の第2の実施形態と切替例



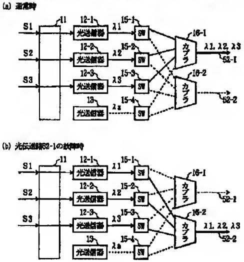
【図6】

波長多重受信手段20の第2の実施形態と切替例



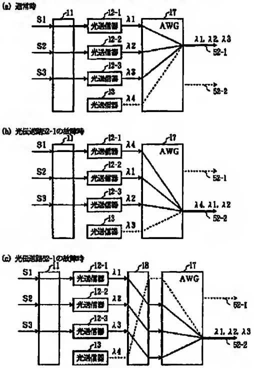
【図7】

光伝送路故障に対する波長多重送信手段10の切替例



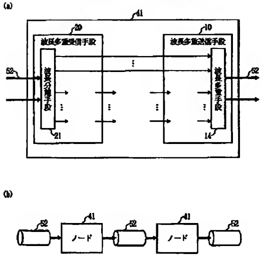
【図8】

光伝送路故障に対する波長多重送信手段10の切替例



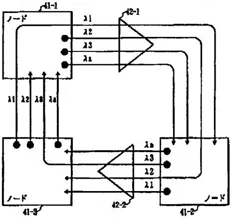
【図9】

光分岐挿入ノード装置の構成例



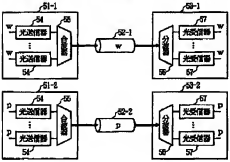
【図10】

3つのノードをリング状に接続した波長多重伝送システムの構成例



【図11】

現用系と予備系を備えた従来の波長多重伝送装置の構成例



【図１２】